PROJECT MANUAL FOR:
CP181391 - SINCLAIR SCHOOL OF NURSING – CONSTRUCT NEW BUILDING
CP200511 - SINCLAIR SCHOOL OF NURSING – WATER LINE REPLACEMENT

AT
UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI

FOR:

THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:

INTERNATIONAL ARCHITECTS ATELIER
912 BROADWAY, SUITE 300
KANSAS CITY, MO 64105
P: 816-471-6522

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SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. MU Division of IT Telecommunications Construction Standards and Specifications apply to this section. The Contractor shall obtain the latest revision of document and install all cables, pathways, boxes, equipment, and hardware in a manner to conform with MU Standards and Specifications.

1.2 SUMMARY
A. Section Includes:
   1. Electrical equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   5. Coordination drawings.
   6. Project record drawings.
   7. Trenching, excavating and backfilling.
   8. Electrical demolition.
   9. Common electrical installation requirements.

1.3 DEFINITIONS
A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS
A. Product Data: For sleeve seals.

1.5 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. All equipment furnished shall be U.L. Listed and labeled or equivalent approved.
C. Comply with NFPA 70.

D. Equipment Selection: Equipment of larger physical dimensions, higher capacities or ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical/electrical services are appropriately modified. Any additional costs as a result of these modifications shall be borne by the Contractor.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver raceways in clean condition. Store to prevent entrance of dirt, debris and moisture.

B. Protect stored raceways, wires, and connectors from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.7 INTERPRETATION OF THE DRAWINGS

A. The drawings indicate diagrammatically the conduit runs and the apparatus served in a general way. No attempt has been made to show exact location of every box, fitting or conduit offset. Such items are to be provided and all wiring connections and home runs are to be made as required. Where conduit runs are shown terminating in arrows, such conduit runs shall be extended to panels/boards or other equipment. Where equipment is specified to be wired, make connections as shown on approved equipment wiring diagrams. Consult equipment approved shop drawings for location of outlets and for miscellaneous controls. Where wire sizes are shown on drawings, the wire size for each circuit shall be for the entire circuit.

B. Where conduit is shown without wiring symbols, install one (1) hot (phase) wire, one (1) neutral wire, and one (1) ground wire.

C. Provide full size neutral for each circuit.

D. No more than three circuits shall be installed in a conduit.

1.8 TEMPORARY POWER

A. The contractor shall make all provisions for and furnish and install all necessary conduit, wire, and distribution equipment for a complete temporary wiring system for use during construction of the building. Temporary wiring shall include a system of temporary lights and power distribution. Refer to Division 01.

1.9 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

E. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

F. Coordinate rough-in connections to pre-manufactured headwall systems including power for lighting, receptacles; connections for nurse call, voice/data outlets and TV interface.

1.10 LOCATION OF OUTLETS

A. Outlets are only approximately located on the construction drawings and great care must be used in the actual location of outlets by consulting architectural drawings and details and the various fixture drawings and by securing definite locations from the Architect.

B. At various places where outlets are shown below exposed pipes or ducts, Contractor shall set outlet box to clear same by at least 12”. Where outlets are installed over piping or ducts, outlets shall be moved so as to clear piping and ducts at no additional cost, using approved conduit and conduit fittings.

C. Switch outlets shall generally be located on lock side of door. Check the latest general drawings on job for door swings before roughing in for switches.

D. Check height of tile or similar wainscots and set switch outlet boxes so that same will clear top of wainscot or will come entirely within the wainscot.

E. Wall outlets installed flush shall be provided with device (plaster) covers set to come flush with the finished surface.

F. For electric water coolers, install box in accordance with manufacturer’s shop drawings so that receptacle will be concealed by unit housing.

G. For other equipment, provide electrical rough-in in accordance with the equipment installation instructions and architectural drawings.

H. Do not use through-the-wall and back-to-back boxes.
PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

3. Pressure Plates: Carbon steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 COORDINATION DRAWINGS

A. The contractor shall prepare CAD generated drawings (min. ¼" scale) showing following systems/items as a minimum:
1. Electrical equipment locations and clearances required.
2. Routing of main feeders and conduits (3" dia. and larger), cable trays and bus ducts.
3. Locations of items in ceiling such as light fixtures.

B. The contractor shall submit the CAD generated drawings to the contractor for coordination with other trades. The drawings shall be submitted either in electronic format or printed copies as requested by the contractor.

C. The contractor shall participate in coordination meetings when requested by the contractor.

2.5 PROJECT RECORD DRAWINGS

A. Drawings shall be furnished in electronic-media (CD-Rewritable type) and at-least one hard copy prints.
   1. Format: Same CAD program, version and operating system as the original contract documents.
   2. Incorporate changes and additional information previously marked on record prints. Delete, redraw and add details and notations where applicable.

B. Identify and date each drawing and include the designation "PROJECT RECORD DRAWING" or "AS-BUILT DRAWING" in a prominent location.

PART 3 - EXECUTION

3.1 TRENCHING, EXCAVATING AND BACKFILLING

A. Excavate to required dimensions and depth. The trench excavation shall be in open cut from surface and shall be minimum width necessary to permit the placing of the pipe as required. Excess excavation shall be backfilled with crusher run rock. Such rocks shall be placed at the Contractor's expense. Lines shall be used to lay out trenches.

B. All excavations shall be properly protected by the necessary bracing and timbers, to prevent any cave-ins or injury to adjacent improvements. The sides of the excavations shall be securely held by bracing or sheathing, which bracing or sheathing shall not be removed until the level of the backfill has reached the point where such removal can be safely carried out. Where adjacent improvements might be injured by the removal of such bracing, the braces shall be left in place to prevent such injury. The thickness of the sheathing and the dimensions of the cross braces, shoes and miscellaneous supports to be used by the Contractor shall be of type required to properly protect the sides of the trench and to prevent injurious cave-ins or erosions.

C. The Contractor shall do all pumping and bailing necessary to keep all excavations free of water and shall provide for the uninterrupted flow of the surface water adjacent to the line of the work during the progress of the work. The Contractor shall inspect the ground where excavation is required to ascertain the structure of the soil. Additional consideration will not be allowed for encountering rock, stone, old foundations or other unfavorable excavating conditions.

D. In cases where existing sewer or other piping are encountered, they shall not be displaced or disturbed. All sewer lines damaged or disturbed in the construction shall be replaced or
required at the Contractor’s expense, unless, in the opinion of the Architect, such damage was caused through no fault of the Contractor.

E. Contractor shall provide all temporary steel plates, barricades, and such other signs and signals by day as shall be necessary to warn the public of and protect the workers from the danger caused by excavations and other obstructions, day and night.

F. The backfilling of trenches shall be carried out as rapidly as the testing and acceptance of the finished sections of the installation will permit. The trench shall be backfilled in layers of not to exceed eight inches (8”) with good selected clean earth, thoroughly tamped with mechanical tamper to a 95% optimum compaction. Density shall be tested by an approved laboratory, using a standard method. Tests shall be made of each 2 ft. depth on the basis of one test per 1000 sq. ft. of fill area. Last 12” of backfill shall be made with good clean top soil. Contractor shall obtain and pay for tests. Submit five (5) copies of tests for approval. Note: Broken stones, cinders, wood and rubbish are not acceptable for backfilling. Backfill all street cuts in a manner meeting the approval of the Architect.

G. In spaces between walls and line of excavation, fill with thin layers of selected clean earth; thoroughly tamp in eight inches (8”) thick layers and bring up to a finished level of established grades. All wood and foreign material shall be removed from excavation prior to backfilling.

H. After backfilling, all surplus excavated materials shall be removed from the property.

I. The work shall be executed so that any existing permanent structure along and adjacent to the new work are properly protected. Any damage occurring to these structures shall be repaired by the Contractor at his own expense.

J. The Contractor shall make field inspection of the location along which the underground conduit is to be routed, and note all obstructions and improvements at the surface which may affect the method of operation in the construction of these conduits. Such underground pipes or conduits which may exist, or which may be encountered, shall be protected by the Contractor during this construction. Any expense or inconvenience caused by their existence and the necessary protection for utilities adjacent thereto shall be considered as covered and included in the contract, without additional cost to the Owner.

3.2 ELECTRICAL DEMOLITION

A. Refer to Division 02 Section “Selective Demolition” for general demolition requirements and procedures.

B. Disconnect, demolish, and remove electrical systems, fixtures, devices, and components indicated to be removed. In general, remove all fixtures, raceways, cables, junction boxes, and equipment not utilized in new construction. For circuits disconnects, remove raceways and cables all way to the source. Label breakers/switches from where circuits have been removed as “SPARE”.

C. Protect existing electrical equipment and installation indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

D. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
E. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish. Raceways shall not be abandoned within walls.

F. Remove demolished material from Project site.

G. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

H. Remove equipment to be salvaged, disconnect from power, and deliver to Owner as directed.

3.3 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. In general install raceways and boxes minimum 8" above hung ceiling. All raceways, boxes and equipment shall be independently supported from structure. Do not support from ductwork or piping.

G. Where new devices are added to existing circuits, take readings prior to adding new devices, and submit to Architect for review. Do not proceed with new work until approved by Architect.

H. All low voltage devices (including but not limited to voice/data communication; nurse call; master antenna television; patient monitoring; telemetry, etc.) that are installed in patient care areas or patient rooms or procedure rooms shall have their conduit extended out to above accessible ceiling space in adjacent corridor. Terminate conduit with a bushing.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping." For communications cable penetrations, comply also with requirements in Division 27 Section "Common Work Results for Communications."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
3.6 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:

1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

C. Pre-wired systems such as type AC (armored cable), type MC (metal-clad and type NM (nonmetallic-sheathed cable) shall not be used. (Exception: MC may be used for lighting fixture whips up to 6'-0" long. They must be dedicated, not daisy chained together).

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing...
Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. All conductors and cables shall be UL labeled.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

B. Coordinate layout and installation of conductors and cables with other trades.

1.7 DELIVERY, STORAGE AND HANDLING

A. Delivery conductors and cables according to NEMA WC 26.

B. Protect stored conductors and cables from moisture and dirt. Do not store outside, exposed to elements. Elevate above grade. Do not exceed structural capacity of floor, when stored inside.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Encore Wire and Cable.
2. Senator Wire & Cable Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.

D. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC or mineral-insulated, metal-sheathed cable, Type MI with ground wire.
2.2 CONNECTORS AND SPLICES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M; Electrical Products Division.
7. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.
PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL AND SIZE APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Conductors smaller than No. 12 AWG shall not be utilized anywhere, unless specifically noted on drawings.

D. The minimum conductor size for branch circuits shall be #12 AWG copper. To compensate for voltage drop, where branch circuit lengths are between 100 and 150 feet, use #10 AWG copper. For branch circuit lengths exceeding 150 feet, use #8 AWG copper.

E. Wire size ampacity shall equal or exceed its overload protective device. Where wire sizes shown on the drawings are greater than the apparent ampacity requirements, the size shown shall prevail to compensate for voltage drop. In no instance shall conductors be installed that are less than required by NEC.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THWN, single conductors in raceway or Type XHHW, single conductors in raceway. Mineral-insulated, metal-sheathed cable, Type MI where specifically indicated on drawings.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

D. Feeders at all other locations: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits at all other locations: Type THHN-THWN, single conductors in raceway.

H. Class 1 Control Circuits: Type THHN-THWN, in raceway.

I. Class 2 Control Circuits: Type THHN-THWN, in raceway.

J. Fire Alarm Circuits: Refer to Section 280513 “Conductors and Cables for Electronic Safety and Security”.

LOW-VOLTAGE ELECTRICAL
POWER CONDUCTORS AND CABLES

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3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal conduits in finished walls, and above ceilings, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed conduits parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support conduits according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and factory color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
   2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both wall surfaces.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."
3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and branch circuit conductors for compliance with requirements.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
   a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of final acceptance.
   b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Test Reports: Prepare a written report to record the following:

   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519
SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. MU Division of IT Telecommunications Construction Standards and Specifications apply to this section. The Contractor shall obtain the latest revision of document and install all cables, pathways, boxes, equipment, and hardware in a manner to conform with MU Standards and Specifications.

1.2 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks.
2. Handholes and boxes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for handholes, boxes, and other structures.
4. Warning tape.
5. Warning planks.

B. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
C. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
   1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

D. Source quality-control test reports.

E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Install Communications / Data / Telephone / CATV ducts, handholes, equipment, and accessories per ANSI/TIA-569-B and BICSI TDMM standards.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify Architect no fewer than seven days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Architect's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities,
underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUIT


B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cantex, Inc.
2. CertainTeed Corp.; Pipe & Plastics Group.
4. Electri-Flex Company.
5. IPEX Inc.
6. Lamson & Sessions; Carlon Electrical Products.
7. Manhattan/CDT; a division of Cable Design Technologies.
8. Spiraduct/AFC Cable Systems, Inc.

B. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC and Type DB-120-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

C. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Christy Concrete Products.
2. Oldcastle Precast Group.
3. Riverton Concrete Products; a division of Cretex Companies, Inc.
4. Utility Concrete Products, LLC.
5. Utility Vault Co.
6. Wausau Tile, Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, "ELECTRIC."/"TELEPHONE."/As indicated for each service.
4. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   a. Extension shall provide increased depth of 12 inches.
   b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   a. Type and size shall match fittings to duct or conduit to be terminated.
   b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

8. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

5. Cover Legend: Molded lettering, "ELECTRIC."/"TELEPHONE./As indicated for each service.

6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.


8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. CDR Systems Corporation.
   d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. Christy Concrete Products.
   d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be polymer concrete.

1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Carson Industries LLC.
   b. Nordic Fiberglass, Inc.
   c. PenCell Plastics.

2.5 SOURCE QUALITY CONTROL

A. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

C. Underground Ducts for Telephone, Communications, Data, or CATV Circuits: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

D. Underground Ducts Crossing Paved Paths, Walks and Driveways or Roadways: RNC, NEMA Type EPC-80-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 structural load rating.

2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 or Polymer concrete, SCTE 77, Tier 15 or Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 Polymer concrete units, SCTE 77, Tier 8 or Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.

4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Excavating, Filling and Grading," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Owner will restore landscaping.

D. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment. Slope ducts from a high point in runs to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 15 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure. Closures and sealing compounds/plugs shall prevent infiltration of gas, water, and vermin.

G. Pulling Cord: Install 100-lbf-test nylon cord in ducts, including spares.

H. In each Communications / Data / Telephone / CATV duct and innerduct, including spares, install 1,500 lb. strength mule-tape pull line with sequential footage mark numbering.

I. When joint-trenches are used to install other utilities along with Communications / Data / Telephone / CATV facilities, the following minimum separation distances shall be maintained:

1. Pipes (gas, water, etc.): 6 inches when crossing; 12 inches when parallel.
2. Power or other foreign conduit: 3 inches of concrete.
J. The total number of bends in a Communications / Data / Telephone / CATV conduit section run shall not exceed 270 degrees of total bends. Each bend shall have a radius not less than 10 times the internal conduit diameter.

K. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concreting Sequence: Pour each run of envelope between other terminations in one continuous operation.
   a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
   b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.

7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated. Install top of Communications / Data / Telephone / CATV duct bank at least 36 inches below finished grade.

8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
   c. Conduit stub-ups through the floor shall extend a minimum 4 inches above the finished floor. The ends of metallic conduit shall be reamed, bushed, and grounded according to the NEC and NESC.
9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

L. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank.
4. Install backfill as specified in Division 31 Section "Trenching, Excavating and Backfilling."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction.
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
   b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.5 INSTALLATION OF CONCRETE HANDHOLES, AND BOXES

A. Precast Concrete Handhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Install handholes with bottom below the frost line, below grade.
2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

3. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains where indicated. Coordinate with drainage provisions indicated.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, minimum 36 inches below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer’s written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screened to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep.

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of sump. Remove foreign material.

END OF SECTION 260543
SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Exterior luminaires, LED modules and drivers.
   2. Luminaire-mounted photoelectric relays.
   3. Poles and accessories.

B. Related Sections include the following:
   1. Division 26 Section "Interior Lighting".

1.3 DEFINITIONS

A. CRI: Color-rendering index.

B. Luminaire: Complete lighting fixture, including ballast housing if provided.

C. Pole: Luminaire support structure, including tower used for large area illumination.

D. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4.

C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4.

D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
   1. Wind speed for calculating wind load for poles exceeding 50 feet in height is 70 mph.
   2. Wind speed for calculating wind load for poles 50 feet or less in height is 70 mph.
1.5 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
   a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
   b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
6. Photoelectric relays.
7. Drivers, including energy-efficiency data.
8. LED modules, including life, output, and energy-efficiency data.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Anchor bolts for poles.
12. Manufactured pole foundations.

B. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.

C. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

D. Qualification Data: For agencies providing photometric data for lighting fixtures.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For luminaries and poles to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.
1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers’ laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C2, "National Electrical Safety Code".

D. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below ground line.

D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.

E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five (5) years from date of final acceptance by Owner.

2. Warranty Period for Metal Corrosion: Five (5) years from date of final acceptance by Owner.

3. Warranty Period for Color Retention: Five (5) years from date of final acceptance by Owner.

4. Warranty Period for LED modules and drivers: Replace LED modules and drivers that fail within twelve (12) months from date of Substantial Completion; furnish replacement LED modules and drivers that fail within the second twelve (12) months from date of final acceptance by Owner.
5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three (3) years from date of final acceptance by Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

   a. Antique Street Lighting.
   b. Architectural Arc Lighting.
   c. Bega/US.
   d. Beta Lighting.
   e. Devine Lighting; Division of Hubbell Lighting.
   f. Gurz Co.
   g. General Electric Lighting Systems, Inc.
   h. Hubbell Lighting Inc.
   i. Holophane.
   j. Kiln Lighting.
   k. Lithonia Lighting.
   l. LSI Lighting Systems.
   m. Lumec.
   n. McGraw-Edison Co.
   o. McPhiblen; division of Thomas Lighting.
   q. Stremer.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning", to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning", or SSPC-SP 8, "Pickling".

2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected from manufacturer's standard catalog of colors.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

   a. Color: As selected by Architect.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

   A. Comply with UL 773 or UL 773A.

   B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.

      1. Relay with locking-type receptacle shall comply with NEMA C136.10.
      2. Adjustable window slide for adjusting on-off set points.

2.4 LED MODULES AND DRIVERS

   A. Comply with LM-79, LM-80 and TM-21 standards for the following:

      2. Color Corrected Temperature (CCT): As noted in Light Fixture Schedule.
      3. Lumen Output: As noted in Light Fixture Schedule.
      4. Lifetime: L70 minimum 50,000 hours.

   B. Dimming: Drivers shall be dimmable down to 1% standard, unless noted otherwise in Light Fixture Schedule, and flicker-free.

   C. Control Voltage: As noted in Light Fixture Schedule.


2.5 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

   A. Structural Characteristics: Comply with AASHTO LTS-4.

      1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
      2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
B. Luminaire Attachment Provisions: Comply with luminaire manufacturers’ mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
   3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete".

E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36 and hot-dip galvanized according to ASTM A 123 and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.6 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
   1. Shape: As indicated.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems", listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
   1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
   2. Finish: Same as pole.

F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
G. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: As selected by Architect from manufacturer's full range.

2.7 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

B. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.2 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
3. Trees: 15 feet.
C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete".

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers, unless otherwise indicated.
4. Use a short piece of 1/2-inch-diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete".

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete".

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems". In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.
3.6 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems".
   1. Install grounding electrode for each pole, unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems".
   1. Install grounding electrode for each pole.
   2. Install grounding conductor and conductor protector.
   3. Ground metallic components of pole accessories and foundations.

3.7 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   1. Verify operation of photoelectric controls.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section "Demonstration and Training".

END OF SECTION 265600
SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Storm Water Pollution Prevention Plan (SWPPP) specifically prepared for this project.

C. Standards and requirements of the University of Missouri.

1.2 SUMMARY

A. This Section includes the following:

1. Protecting existing trees and vegetation to remain.
2. Removing existing trees and vegetation
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and abandoning existing site utilities in place and/or removing existing site utilities when indicated.
7. Temporary erosion and sedimentation control measures.

B. Related Sections include the following:

1. Division 01 Section "Temporary Controls and Facilities" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities.
2. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
3. Division 02 Section "Structure Demolition" for demolition of buildings and/or structures.
4. Division 02 Section "Selective Structure Demolition" for partial demolition of buildings and/or structures.

1.3 DEFINITIONS

A. Subsoil: All soil beneath topsoil, as defined below, and typified by the lack of organic matter and soil organisms.

B. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of weeds, roots, toxic materials, or other non-soil materials.

1. Existing topsoil may require screening or amendment before being considered suitable
C. Tree Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

D. Vegetation: Trees, shrubs, groundcover, grass, and other plants.

E. Best Management Practices (BMP's) means schedules of activities, prohibition of practices, maintenance procedures, and other management practices to prevent or reduce pollution. BMP's also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

F. Storm Water Pollution Prevention Plan (SWPPP): Separately bound document prepared exclusively for this project which to aid in the implementation, management, and maintenance of Best Management Practices (BMPs) during construction activities so as to minimize erosion, reduce the amount of sediment in storm water runoff, comply with the water quality standards, and ensure compliance with the provisions of the General Permit.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, all cleared materials shall become Contractor's property and shall be removed from Project site.

B. Removed material shall be disposed of on legally approved sites and in compliance with requirements of regulatory agencies.

1.5 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product data for the following:

C. Reports, records, and certifications required by this Section, regulatory agencies having jurisdiction, and permit requirements.

1.6 PROJECT CONDITIONS

A. Construction operations are to be limited to the project limits only. Workers, equipment, or materials onto adjacent areas is strictly forbidden.

B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises as directed.

D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

F. The following practices are prohibited within tree protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving."

   1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.
   2. Submit product data information on proposed off-site borrow materials according to the requirements specified in Division 31 Section "Earth Moving."

2.2 EROSION CONTROL DEVICE MATERIALS

A. Anti-Erosion Mulch: Clean, dry straw of winter wheat, rye, oats, or barley.

B. Silt Fence Fabric: Synthetic filter fabric or a pervious sheet of polypropylene, nylon, polyester, or polyethylene yarn, containing ultraviolet ray inhibitors and stabilizers providing a minimum of six months usable construction life at a temperature range from 0 to 120 degrees F., and meeting the following requirements:

   1. Filtering efficiency: Not less than 75 percent.
   2. Grab strength at 20 percent maximum elongation:
      a. Standard Strength Fabric: 30 pounds per lineal inch.
      b. Extra Strength Fabric: 50 pounds per lineal inch.
3. Flow Rate: Not less than 0.20 gallons per square foot per minute.
4. Ultraviolet radiation stability: 90%

C. Silt Fence Posts: Contractor has option of the following.
   1. 4 inch diameter pine.
   2. 2 inch diameter oak.
   3. 1.333 pound per lineal foot steel posts, a minimum of 4-feet in length.
      a. Steel posts shall have projections for fastening the fabric.

4. Plastic posts designed to be specially incorporated into, or work with, a silt fence fabrication.

D. Non-woven geotextile separation blanket: Synthetic filter fabric or a pervious sheet of polypropylene, nylon, polyester, or polyethylene yarn manufactured for the purpose of providing separation between soil material layers.

E. Temporary Seeding: Annual plant or mixture of annual plant seeds, free of weed and invasive seeds, capable of providing temporary surface restoration.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper and timely completion.
      1. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Protect and maintain benchmarks and survey control points from disturbance during construction.
   B. Locate and clearly identify trees, shrubs, and other vegetation to remain.
   C. Protect existing site improvements to remain from damage during construction.
      1. Restore damaged improvements to their original condition at no additional cost to Owner, as acceptable to Owner.
   D. Use all means necessary to control dust on and near the work, and on and near off-site storage, and spoil areas, if such dust is caused by performance of the work of this Section, or if resulting from the condition in which Project Site is left by Contractor.
   E. Moisten surfaces, as required, to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of other work on Project Site.
F. Install temporary construction entrances.

3.3 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways according to requirements of authorities having jurisdiction, erosion and sediment control plans, the Storm Water Pollution Prevention Plan (SWPPP) prepared for this project and bound separately, and provision of the permit issued pertaining to site clearing and temporary erosion control operations.

B. Install erosion control systems at the site's boundary at locations where storm water runoff will leave the site prior to starting any clearing, stripping, or earthwork operations.

C. Minimize the time areas are to be exposed without vegetative cover.

D. Clearing and grubbing within 50 feet of a defined drainage way is strictly prohibited unless such activity is clearly indicated and then shall not commence until the specific erosion control systems and BMP's for that specific area are in place.

E. Properly dispose of solid waste, paints, solvents, cleaning compounds, etc.

F. Store construction materials in designated areas away from drainage ways and low areas.

G. Provide portable toilets and properly dispose of sanitary sewage.

H. Construct containment berm and utilize drip pans at fuel and liquid storage tanks and containers.

I. Minimize areas to be stripped to those areas of construction activity.

J. Phase construction operations to minimize area of disturbed soil.

K. Exposed surfaces shall be roughened to inhibit runoff and promote infiltration.

L. At completion of topsoil stockpiling operations, stockpiles shall be shaped and graded to drain.

M. Installation of Erosion Control Devices

1. Install erosion control devices to protect adjacent and downstream properties from damage and pollution resulting from erosion caused by the work of this Contract.

2. Implement erosion control measures indicated on drawings and additional erosion control measures necessary to prevent damage to adjacent and downstream properties.

3. Install additional erosion control devices as required by the municipality having jurisdiction.

4. Install silt fence located along perimeter of site or grading limits immediately following site clearing and grading operations.

   a. Install silt fence fabric from a continuous roll for the length of the silt fence whenever possible to minimize the number of joints.

   b. Create joints in fabric by securely fastening fabric at the support post with overlap.
extending to the next post.

c. Drive support post into ground not less than 24 inches.
d. Excavate a 4 inch wide by 6 inch deep trench on up-slope side of silt fence.
e. Line trench with silt fence fabric material.
f. Backfill trench with soil or gravel.

5. Install temporary construction entrance(s).

6. Install sediment traps around surface inlets.

7. Install concrete wash pits.

8. Establish temporary vegetative cover in areas that are not disturbed for a period of 14 days.

N. Inspection of Erosion and Sediment Control Systems

1. Inspect all erosion control systems and devices according to the SWPPP for the project.
2. Inspect all erosion control systems and devices at least once every seven calendar days.
3. Inspect all erosion control systems and devices within 24 hours of the end of any rainfall event which results in precipitation of 1/2 inch or more.
4. During inspections, locations where storm water leaves the site shall be inspected for evidence or erosion or sediment deposition.
5. Correct deficiencies within three calendar days.
6. Complete a report of each inspection. Report shall contain the following minimum information:
   a. Inspector's name
   b. Inspection date
   c. Observations of the effectiveness of erosion control systems
   d. Actions taken if necessary to correct deficiencies
   e. Listing of areas where construction operations have permanently or temporarily stopped
   f. Authorized signature

O. Maintenance of Erosion and Sediment Control Devices

1. Maintain all installed erosion and sediment control devices according to the SWPPP for the project.
2. Check all erosion control measures after each rainfall event to ensure that they are in proper working order.
   a. Immediately restore all measures to installed condition.
3. Inspect erosion control fences at least once a week.
4. Immediately replace damaged portions of the erosion control fences, including portions which have collapsed, contain tears, have decomposed, or have become ineffective.
5. Remove sediment deposits, as necessary, to provide adequate sediment storage and to maintain the integrity of fences. Dispose of accumulated sediment by spreading over upland areas of the site.
6. Maintain erosion control devices in place, as specified, until completion of the work of this Contract and until permanent stabilization of all disturbed areas is achieved.
   a. At completion of work, inspect all systems, make necessary repairs, remove and dispose of all accumulated sediment, and turn completely operable systems indicated to remain over to Owner for continued maintenance.

P. Remove erosion and sedimentation controls not indicated to remain and restore and stabilize
areas disturbed during removal.

Q. Chemical and sewage spills
   1. Report hazardous substance or oil spills in accordance with requirements of 40 CFR 117 and 40 CFR 302.
   2. Report discharge or escape of sewage, substances, or waste which may contaminate or pollute water or soil to the Missouri Department of Natural Resources.

R. Removed Substances
   1. Solids, sludges, sediments, or other pollutants removed in the control of runoff shall be managed in accordance with applicable statutes and regulations.

3.4 EXISTING UTILITIES

A. Arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing. Coordinate disconnection with Owner as necessary.
   1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed or abandoned in place.
   1. Arrange with utility companies to shut off indicated utilities.

C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Architect not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.

D. Excavate for and remove underground utilities indicated to be removed.

E. Excavate ends of underground utilities indicated to be abandoned and install permanent cap.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain.
   2. Remove all roots (entire rootball) of trees indicated to be removed.
   3. Chip removed tree branches and dispose of off-site.
   4. Use hand methods only for grubbing within tree protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
SINCLAIR SCHOOL OF NURSING – WATER LINE REPLACEMENT

1. Place fill material according to the requirements specified in Division 31 Specification “Earth Moving.”

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Install additional erosion control devices at stockpile areas.
2. Stockpile surplus topsoil for respreading following final grading operations.
3. Dispose of excess topsoil as directed by Owner.

3.7 SITE IMPROVEMENTS

A. Remove or abandon existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

1. If plans indicate abandonment of improvements but removal is required to facilitate construction, proceed with removal of improvements at no additional cost to Owner.

B. Existing building foundation systems are to be removed in their entirety.

C. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Remove concrete walks and sidewalks to nearest joint beyond line of demolition.
2. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
3. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000
SECTION 312000 – EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Geotechnical Report prepared by Engineering Surveys & Services titled *Subsurface Investigation, Soil Analysis and Foundation Design Recommendations for University of Missouri Sinclair School of Nursing* dated February 22, 2019 prepared specifically for this project.

C. Storm Water Pollution Prevention Plan (SWPPP) specifically prepared for this project.

1.2 SUMMARY

A. This Section includes the following:

1. Excavating and backfilling trenches.
2. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

B. Related Sections include the following:

1. Division 01 Section "Unit Prices" for a schedule of unit prices.
2. Division 01 Section "Construction Facilities and Temporary Controls."
3. Division 03 Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
4. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removing topsoil above- and below-grade improvements including utilities, and protecting trees to remain.
5. Division 32 Section "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.

1.3 DEFINITIONS

A. Authorized Additional Excavation: Removal of materials beyond indicated subgrade elevations and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices or changes in the work.

B. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.
C. Base Course: The layer placed between the subgrade and surface pavement in a paving system.

D. Bedding Material: Granular material utilized to bed piped utilities placed in trench excavations.

E. Borrow Material: Material obtained off-site use for fill or backfill when sufficient approved soil material is not available from excavations.

F. Controlled Low Strength Material: High slump concrete, commonly referred to as Flowable Fill.

G. Drainage Fill: Course of washed granular material supporting slab-on-grade placed to minimize upward capillary flow of pore water.

H. Excavation: The removal of material encountered to subgrade elevations and the reuse or disposal of materials removed.

I. Fill: Soil material used to raise elevations.

J. Low Volume Change Soil Material: Low-plasticity soil material.

K. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.

L. Subgrade: The uppermost surface of an excavation, including excavation for trenches, or the top surface of a fill or backfill immediately below base course, pavement, drainage fill, or topsoil materials.

M. Subsurface Drainage Backfill: Granular material utilized to backfill walls or utilized to backfill subsurface trench drainage systems.

N. Unauthorized Excavation: Removing materials beyond indicated subgrade elevations or dimensions without direction by the Architect. Unauthorized excavation, as well as remedial work directed by the Architect, shall be at the Contractor's expense.

O. Unforeseen Excavation: Excavation of material, regardless of its character or nature, below the subgrade elevation required to construct the work as indicated on the drawings or specified herein. Unforeseen excavation shall be at the Contractor's expense.

P. Utilities: Underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 01 Specifications.

B. Product Data: For the following:

1. Each type of plastic warning tape.
C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill.

D. Photographs of existing adjacent structures and site improvements, for record purposes only.

1.5 QUALITY ASSURANCE

A. Pre-Excavation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

B. Codes and Standards: Perform earth moving operations complying with requirements of authorities having jurisdiction.

C. Testing and Inspection Service: Owner will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soil materials to verify that soils comply with specified requirements and to perform required field and laboratory testing.

1.6 PROJECT CONDITIONS

A. The existing utility information shown on the Drawings is based on the best available information. The exact location and depth of these utilities are unknown. Contractor shall perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located. Contractor to notify Architect in writing should existing utilities be discovered.

B. Site Information: Reports on subsurface condition investigations made during design of Project are available and are for informational purposes only. Data in reports are not intended as representations or warranties of accuracy or continuity of conditions between soil borings. Owner assumes no responsibility for interpretations or conclusions drawn from this information.

C. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

D. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated:

   1. Notify Architect not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.
   3. Contact utility-locator service for area where Project is located before excavating.
E. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures are in place.

F. Do not commence earth moving operations until plant-protection measures specified in Division 01 Section "Temporary Tree and Plant Protection" are in place.

G. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

H. Do not direct vehicle or equipment exhaust towards protection zones.

I. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

J. Demolish and completely remove from site existing underground utilities indicated to be removed. Cap ends of existing underground utilities indicated to be abandoned. Coordinate with utility companies to shut off services if lines are active.

K. Utilities have been located from surveys and available existing records. Not all utilities may be shown on the Drawings. Locate all utilities prior to beginning any construction activities.

L. Where utilities require adjustment or relocation to construct the Work, and those utilities are not shown on the Drawings, notify Architect before proceeding. Relocate or adjust utility as directed. All utility adjustment and/or relocation work shall be at the Contractor's expense.

M. If utility is damaged by Contractor, notify utility owner and Architect immediately. Repair or replacement of utilities damaged by Contractor, whether utilities are shown on the drawings or not shown on the drawings, shall be Contractor's expense.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 soil classification groups GC, GW, GP, GM, SC, SW, SP, SM, ML, MH and CL or CH or a combination of these group symbols; free of rock or gravel larger than 2 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: ASTM D 2487 soil classification groups OL, OH, and PT, or a combination of these group symbols.
1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Aggregate Base Course: Crushed stone meeting the gradation requirements of a MoDOT Type 1 aggregate.

E. Bedding Course: Clean, granular materials of crushed rock or pea gravel with not less than 95 percent passing a 3/4 inch sieve and not less than 95 percent retained on a 3/8 inch sieve.

F. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57.

G. Subsurface Drainage Backfill Material: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57

H. Impervious Fill: Clay soils capable of compacting to a dense state.

I. Low Volume Change Soil Material: Granular material or low plasticity cohesive soils having a liquid limit less than 50 and a plasticity index less than 30, as approved by Owner's Testing and Inspection Service.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:

2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavation is unclassified and includes excavation to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials at no additional cost to the Owner.

B. Borrow Material: If excavated materials of a suitable nature are not of sufficient quantity to complete the work, provide borrow material in sufficient quantity to complete the work at no additional cost to the Owner.

C. Disposition of Excavated Material: Dispose of excess satisfactory soil material and all unsatisfactory soil material and rock obtained from excavations in accordance with the provisions of this Section.

3.5 STABILITY OF EXCAVATIONS

A. Comply with local, state, and federal codes, ordinances, and regulations regarding maintaining safe and stable excavations.

3.6 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1.2 inches. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations from 6 to 12 inches (150 to 300 mm) above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.

3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1.2 inches. Do not disturb bottom of excavations intended for bearing surface.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-line spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Where utilities are in fill, compact fill material to 95% standard proctor maximum dry density at least 12" above the top of the proposed utility prior to excavation of trench.

B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

C. Trench Bottoms when no bedding course is indicated: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.

2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.

3. If rock or other unyielding material is encountered at required trench bottom elevation, excavate trenches 6 inches deeper than subgrade elevation required to allow for installation of a 6 inch thick bedding course.

   a. Excavation and disposal of all material, regardless of character, and placement of suitable bedding material shall be at the Contractor’s expense.

D. Trench Bottoms when bedding course is indicated: Excavate trenches to depth below bottom of utility indicated to allow for bedding course. Hand excavate for bell of pipe.

3.8 APPROVAL OF SUBGRADE
A. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner’s Testing and Inspection Service at no additional cost to Owner.

B. Notify Architect and Owner’s Testing and Inspection Service when excavations have reached required subgrade.

C. If Owner’s Testing and Inspection Service determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
   1. Additional excavation and replacement material will be at the Contractor’s expense.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by Owner’s Testing and Inspection Service.
   1. Fill unauthorized excavations under other construction or utility pipe as directed by Owner’s Testing and Inspection Service.

B. Where indicated widths of utility trenches are exceeded, provide stronger pipe, or special installation procedures, as required by the Owner’s Testing and Inspection Service.

C. All additional costs incurred as a result of unauthorized excavation are the Contractor’s responsibility.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for record documents.
   3. Inspecting and testing underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.
   7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Coordinate backfilling with utilities testing and installation of warning tape.
   1. Install warning tape directly above utility line.

D. Trenches under Roadways: Provide 4-inch thick concrete-base slab support for piping or conduit less than 24-inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section Cast-in-Place Concrete.

E. When excavation wall protection has been utilized, fill voids with approved materials while shoring and bracing, and as sheeting is removed.

F. Place and compact initial backfill of material indicated, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit.
   1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

G. Place and compact final backfill of material indicated to final elevation required.

H. Water Piping Backfill

  1. Materials shall consist of sand or crushed stone aggregate with 95% passing a ½” sieve but not more than 10% passing a #200 sieve.
  2. The first one foot of backfill over the top of the pipe shall be ¾” minus waste rock with fines uncleaned crushed stone aggregate.

3.13 MOISTURE CONTROL

A. General Fill: Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to between -2% and +4% of optimum moisture content.
   1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air-dry, otherwise “Satisfactory Soil” material which exceed -2% and +4% of optimum moisture content or is too wet to compact to specified density.

B. Building Fill: Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to between 0% and +4% of optimum moisture content.
3.14 COMPACTION OF BACKFILLS AND FILLS

A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil to not less than the following percentages of Standard Proctor maximum dry density according to ASTM D 698:
   1. Under structures, building slabs, steps, stairs, walks, ramps, and pavements, scarify and recompact top 9 inches of existing subgrade and each layer of backfill or fill material to not less than 95 percent of Standard Proctor maximum dry density.
   2. Under lawn or unpaved areas, scarify and recompact top 9 inches below subgrade and compact each layer of backfill or fill material to not less than 90 percent of Standard Proctor maximum dry density.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.
   1. Field in-place density tests may also be performed by the nuclear method according to ASTM D 6938, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556.
   2. When field in-place density tests are performed using nuclear methods, make calibration check of both density and moisture gauges at the beginning of work, on each different type of material encountered, and at intervals directed by the Architect.
   3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench length, but no fewer than two tests.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.16 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Owner's Testing and Inspection Service; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 312000
SECTION 331000 – FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Standards and Specification of the University of Missouri.

1.2 SUMMARY

A. This Section includes piping and specialties for combined potable-water and fire-protection water service

B. This Section includes furnishing and installing all fittings required to construct the work whether or not such fittings are indicated on the drawings.

C. Only University of Missouri Campus Facilities – Energy Management Steam and Water personnel are allowed to operate valve on existing and new water systems. All new valves are to remain in the closed position until opened by authorized personnel.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Minimum Working Pressures: The following are minimum working pressure requirements for piping and specialties, unless otherwise indicated:


1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

1. Each sheet or page of each submittal whether shop drawings or product data, shall bear the review stamp of the Contractor indicating the submittal has been reviewed and is approved. Submittals not bearing the Contractor’s stamp will be returned without review.

2. Contract drawings may not be reproduced in whole or in part to be utilized as a submittal. Contract drawings reproduced in whole or in part and modified into submittals will not be accepted and will be returned without review.

3. Shop drawings shall be complete for each component or item. Indicate all dimensions, location of embedded items, all reinforcing steel sizes, spacing, lengths, and locations.
Submission of typical shop drawings for separate components or items but not indicating the specifics of each will not be accepted and will be returned without review.

B. Product Data: For the following:

1. Pipe and fittings.
2. Valves.
3. Fire hydrants.
4. Identification materials and devices

C. Shop Drawings: For precast and cast-in-place concrete structures. Include frames and covers and drains.

D. Record Drawings: At Project closeout of installed water-service piping according to Division 1 Section "Contract Closeout."

E. Test Reports: As specified in "Field Quality Control" Article in Part 3.

F. Purging and Disinfecting Reports: As specified in "Cleaning" Article in Part 3.

G. Maintenance Data: For specialties to include in the maintenance manuals specified in Division 1. Include data for the following:

1. Valves.
2. Fire hydrants.

1.5 QUALITY ASSURANCE

A. Comply with requirements of utility supplying water. Include tapping of water mains and backflow prevention.

B. Comply with NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances," for materials, installations, tests, flushing, and valve and hydrant supervision.

1.6 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors, unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dewpoint temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
C. Handling: Use sling to handle valves and fire hydrants whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use hand wheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. The existing utility information shown on the Drawings is based on the best available information. The exact location and depth of these utilities are unknown. Contractor shall perform site survey, research utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located. Contractor to notify Architect in writing should existing utilities be discovered.

B. Verify that water system piping may be installed to comply with Drawings, these specifications, and referenced standards. Contact Architect immediately if modifications to the design are required.

C. Site Information: Reports on subsurface condition investigations made during design of Project are available and are for informational purposes only. Data in reports are not intended as representations or warranties of accuracy or continuity of conditions between soil borings. Owner assumes no responsibility for interpretations or conclusions drawn from this information.

D. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted and then only after arranging to provide temporary utility services according to requirements indicated. Refer to Project Special Conditions for additional information and requirements.

E. Demolish and completely remove from the site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

F. Where utilities require adjustment or relocation to construct the Work, and those utilities are not shown on the Drawings, notify the Architect before proceeding. Relocate or adjust utility as directed. All utility adjustment and/or relocation work shall be at the Contractor’s expense.

G. If utility is damaged by Contractor, notify utility owner and Architect immediately. Repair or replacement of utilities damaged by Contractor, whether such utilities are shown on the drawings or not shown on the drawings, shall be at Contractor’s expense.

H. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted and then only after arranging to provide temporary water-distribution service according to requirements indicated. Refer to Project Special Conditions for additional information and requirements.
1.8 SEQUENCING AND SCHEDULING

A. Coordinate connection to water systems with University of Missouri.

B. Coordinate piping materials, sizes, entry locations, and pressure requirements with building water distribution piping.

C. Coordinate piping materials, sizes, entry locations, and pressure requirements with building fire-protection water piping.

D. Coordinate with other utility work.

E. Coordinate with other site work.

F. Coordinate with adjacent projects.

PART 2 - PRODUCTS

2.1 PIPES AND TUBES

A. General: Applications of the following pipe and tube materials are indicated in Part 3 "Piping Applications" Article.

B. Ductile-Iron Pipe: AWWA C151, minimum thickness class 52 or pressure class 350.
   1. Lining: AWWA C104, cement mortar, seal coated.
   2. Gaskets, Glands, Bolts and Nuts: AWWA C111.
   3. Mechanical-Joint Pipe: AWWA C111, rubber gaskets ductile iron or cast iron glands, and steel nuts and bolts.
   4. Polyethylene encasement per AWWA C105.

C. Polyvinyl Chloride Pipe (PVC): AWWA C900, pressure class 235 (DR 18) with bell end and elastometric gasket.
   1. Comply with UL 1285 for fire-service mains if indicated.
   4. Link Assembly: Interlocking synthetic rubber link assembly, Link-Seal by PSI-Thundertech Corporation, or approved equal.
   5. Gaskets: ASTM F477.

2.2 PIPE AND TUBE FITTINGS

A. General: Applications of the following pipe and tube fitting materials are indicated in Part 3 "Piping Applications" Article.
B. Ductile-Iron, Mechanical-Joint Fittings: AWWA C153, ductile-iron, compact type. Include cement-mortar lining and seal coat according to AWWA C104 and glands, rubber gaskets, and bolts and nuts according to AWWA C111.

C. Polyethylene encasement: AWWA C105, 8-mil minimum thickness, tube or sheet.

2.3 VALVES

A. Non-rising-Stem, Resilient-Seated Gate Valves, 3-Inch NPS and Larger: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut. Include 250-psi minimum working-pressure design, interior coating according to AWWA C550, and mechanical-joint ends.

1. Model A-2360 by Meuller Company, or approved equal.

B. Valve Boxes: 6” PVC C900 with cast iron cover top section and cover with lettering "WATER,"

1. No. 2195 by Clay & Bailey Manufacturing, or approved equal.

C. Indicator Posts: UL 789, FM-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of bury of valve.

2.4 JOINT RESTRAINTS

A. Refer to Part 3 section “Joint Construction” for material and product requirements.

2.5 FREESTANDING FIRE HYDRANTS

A. Super Centurion Fire Hydrants, Model 250, Number A-423 by Mueller Water Products.

B. Color, Sign Painters’ 1 Shot Lettering Enamel as indicated:

2. Caps – Blue.

2.6 ANCHORAGES

A. Rods, nuts, and washers: 3/4” SS304.

B. Concrete Reaction Backing: Portland cement concrete mix, 3000 psig.

1. Cement: ASTM C 150, Type I.
2.7 IDENTIFICATION

A. Warning Tape: Refer to Division 31 Section "Earth Moving" for material and product requirements.

B. Tracer Wire: #14 AWG tracer wire, steel core. 250 pound average tensile break load, 30 mil high molecular weight, high density blue polyethylene jacket complying with ASTM D 1248, 30-volt rating.
   1. Copperhead Industries HS-CCS, or approved equal.

C. Tracer Wire Splices: Moisture resistant.
   1. Copperhead Industries Snakebite, 3M DBR, or approved equal.

D. Tracer Wire Test Stations: Copperhead Industries Snake Pit, or approved equal. Blue lid, brass terminal for attaching locating equipment, brass 5 sided nut for removing cap. Attach magnet at the top of the rubber tube of box for locating purposes.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavation, trenching, and backfilling.

B. Warning Tape
   1. Install warning tape 24" above top of pipe directly over pipe.

C. Tracer Wire
   1. Tape trace wire to the top of each water line with duct tape every five (5) feet. Minimize wire splices.
   2. Terminate trace wire inside building and inside valve boxes.
   3. Drill 1/4" hole in PVC valve box 1' below cast iron cover. Route wire up outside of valve box, through 1/4" hole and knot.
   4. Install tracer wire test station at all fire hydrants and at all runs of piping without valves every 400 feet.
   5. Following final grading Contractor to complete a continuity test on tracer wire. Repair all breaks as required.

D. Refer to Division 32 Section "Concrete Paving" for cutting and patching of paving.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications:
B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.

C. Do not use flanges or keyed couplings for underground piping.
   1. Exception: Piping in boxes and structures, but not buried, may be joined with flanges or keyed couplings instead of joints indicated.

D. Flanges, keyed couplings, and special fittings may be used on aboveground piping.

E. Combined Fire/Potable Water-Service Piping: Use the following:
   1. PVC piping: AWWA C900, ductile iron mechanical-joint fittings and gasketed joints.

3.3 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Underground Valves, 3-Inch NPS and Larger: AWWA, gate valves, nonrising stem, with valve box.

3.4 JOINT CONSTRUCTION

A. Mechanical joint pipe restraint: AWWA C111, FM approved, retainer type packing glands with rubber gaskets.
   1. Megalug 2000 PV by EBAA Iron Inc, or approved equal.

B. PVC Joint Retainers: Ductile iron split serrated ring harnesses and rod type joint retainers for PVC bell and spigot joints, FM approved.
   2. Restraint harness: Series 1500 by EBAA Iron Inc, or approved equal.

C. Flanged Joints: Align flanges and install gaskets. Assemble joints by sequencing bolt tightening. Use lubricant on bolt threads.

3.5 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping at minimum depth and vertical and horizontal clearances as indicated.

B. Install components with pressure rating equal to or greater than system operating pressure.

C. Locate pipes parallel to each other to extent practical, spaced to permit valve servicing.

D. Install fittings for changes in direction and branch connections.
E. Install underground piping with restrained joints at horizontal and vertical changes in direction as required or indicated on Drawings. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports as indicated on Drawings or required by utility company.

F. Piping Connections: Unless otherwise indicated, make piping connections as specified below:
   1. Install unions, in piping 2-inch and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch or smaller threaded pipe connection.
   2. Install flanges, in piping 2-1/2-inch and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
   3. Install dielectric fittings to connect piping of dissimilar metals.

3.6 PIPING INSTALLATION – DIRECT BURY
   A. Comply with NFPA 24 for fire-protection water-service piping materials and installation.
   B. Install ductile-iron piping according to AWWA C600.
      1. Encase piping with polyethylene film according to AWWA C600.
   C. Install PVC in accordance with C605.
   D. All joints shall be restrained with joint retainers. All fittings shall be restrained with retainer type packing glands.
   E. Bury piping with depth of cover over top of pipe of at least 42 inches.
   F. Install piping under streets and other obstructions that cannot be disturbed, by tunneling, jacking, or combination of both.

3.7 PIPING INSTALLATION – BORED SYSTEMS
   A. Field verify location and depth of existing utility systems. Complete excavation such as vacuum excavation to visually locate existing systems.
   B. Avoid damage to existing tree root systems for trees indicated to remain.
   C. Install in accordance with piping manufacturer’s requirements and recommendations.
      1. Comply with piping system manufacturer’s requirements on maximum pulling force, minimum bend radius, maximum deflection, and other requirements.
   D. Utilize directional drilling equipment in compliance with restrained joint piping systems manufacturer’s instructions
   E. Advance pilot bore and plot vertical and horizontal location at intervals not exceeding 20 linear feet.
1. Pilot bore shall not deviate from plan location more than 5 feet over a length of 100 feet. If pilot bore deviation is greater than 5 feet, notify Engineer prior to further advancement of pilot bore.

F. Construct pressure relief holes at intervals to prevent buckling of paving. All paving systems damaged shall be removed and replaced at the Contractor's expense.

G. Install tracer wire and pull with pipe. No splices of tracer wire will be accepted.

H. Finished Location:
   1. Provide a minimum depth of cover over top of pipe of at least 42 inches.
   2. Finished piping location shall be a minimum of 12 inches of separation from all existing and proposed utilities.
   3. Maintain a minimum of 10 feet of horizontal separation from sanitary sewer systems.
   4. Maintain a minimum of 18 inches of vertical separation from sanitary sewer systems.

3.8 VALVE INSTALLATION
   A. General Application: Use mechanical-joint-end valves for 3-inch and larger underground installation. Use nonrising-stem UL/FM gate valves for installation with indicator posts.
   B. AWWA-Type Gate Valves: Comply with AWWA C600. Install underground valves with stem pointing up.

3.9 FIRE HYDRANT INSTALLATION
   A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
      1. Pumper nozzle shall be installed pointing away from the building.
   B. UL/FM-Type Fire Hydrants: Comply with NFPA 24.

3.10 IDENTIFICATION INSTALLATION
   A. Install continuous plastic underground warning tape during back filling of trench for underground water-service piping. Locate 24 inches directly above piping.

3.11 CLEANING, DISINFECTION & LEAKAGE TESTING
   A. General: Testing shall be performed by the Owner. Contractor shall prepare water line for testing and disinfection. Contractor to notify Owner at least 72 hours prior to requesting disinfection.
   B. Flush system with clean potable water with maximum water pressure until no chlorine remains at any point of outlet.
C. System shall be placed in operation only after testing shows the absence of bacteriological contamination and approved by Owner.

END OF SECTION 331000